

Gender Differences in BMI and Mid-Upper arm Circumference Distribution in Nigerian Children

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ABSTRACT

The anthropometric characteristics of 600 normal Nigerian children of ages between 5-10 years of Gbagyi tribe of Abuja Nigeria with no obvious deformities or previous history of trauma were selected for this study. Of these children, males (n=300) with mean age of 7.10 ± 1.98 , and females (n=300) with mean age of 7.68 ± 1.86 were investigated. The anthropometric characteristic of their age, height, weight, Body mass index (BMI), mid-upper arm circumference (MUAC) and chest circumference was measured and analyzed statistically for any significant difference, and correlation between the parameters studied. The results show some significant differences ($P \leq 0.05$) between the anthropometric parameters and a significant correlation (≤ 0.001) between the BMI and Mid-upper arm circumference and other parameters. The study derived a linear regression and a multiple linear regression equations for Nigerian children of Gbagyi tribe from which height, age, weight, MUAC, chest circumference, and body mass index could be predicted if one factor is known. The results from the present study provided an insight into the nutritional status of Nigerian School children of Gbagyi tribe of Abuja Nigeria using the body mass index and MUAC which showed if a child is malnourished, overweight or obese. The results from the present study show that there is a positive correlation between height and BMI and between BMI and MUAC other parameters indicating that height could be predicted using age, weight, chest circumference, MUAC and body mass index, while body mass index and mid upper arm circumference could be used to estimate the nutritional status among Nigerian School Children of Gbagyi tribe of Abuja-Nigeria.

Keywords: Gender, BMI, Height, MUAC, Anthropometry, School Children, Nigeria, Gbagyi tribe

INTRODUCTION

Determination of the body sizes such as height, weight, Body mass index (BMI) and Mid-upper arm circumference (MUAC) are required for assessment of growth, nutritional status, calculating body surface area and predicting pulmonary function in both male and female children [1,2]. Measurement of BMI and MUAC are important for the determination of the basic energy requirement, standardization, and measures of physical capacity and for adjusting drug dosage [3].

The BMI was found to be the most reliable alternative to measuring height and weight and can be used as a basis for estimating age-related loss in height [4, 5]. The length of the body while alive is one of the key parameters established in the course of identification of unknown skeletal remains [6, 7, 8]. Stature provides insight into various features of a population including; nutritional health and genetics and is considered as one of the parameters for personal identification [6, 9, 10].

The most important applications of anthropology at field level include biological anthropology, epidemiology, clinical application and metabolic research [10, 11]. Protein Energy Malnutrition (PEM) is the most widespread form of malnutrition in the world today affecting over 500 million children [12]. Protein Energy Malnutrition and obesity are hazardous to health with high morbidity and mortality rates [13, 14, 15]. The assessment of body composition is essential to prevent, diagnose and determine the

severity of these disorders as well as their response to therapy [13, 14, 15].

The height could be used to predict body BMI status and body surface area independent of the sex of the individual. Hand length has been shown to be a reliable and precise means in predicting the height, weight and BMI of an individual [16, 17].

In forensic Investigations, the dimensions of the hand and foot have been used for determination of sex, age, stature of an individual. Stature reconstruction is important as it provides forensic anthropological estimation of the height of a person in the living state; playing a vital role in the identification of individuals.

Intact long limb bones have been used in the derivation of regression equations for stature assessment in different population groups. Anthropologist observes and compared the relation between body and segments to highlight variations between and within groups [18, 19]. Determination of stature is a major of concern in forensic medicine and forensic anthropology. The bone area values at different sites strongly relates to muscle strength and parameters related to body size which include height, weight, lean body mass, fat mass and BMI [20, 21]. It is commonly accepted that standards for skeletal identification vary among different populations and the standard for one population may not be used for another [22].

When the health risk is defined in terms of body mass, body size and dimensions, western Caucasian standards have by default become the international standard, although there is mounting evidence that these western standards may not be applicable to all races [23, 19, 24]. Krishan and Sharma studied the limb asymmetry and its effect on estimation of the stature [10], while Bidmos studied the evaluation of the accuracy of the direct and indirect methods in stature reconstruction [15]. Kanchan and others established the relationship between hands and feet and its value in personal identification in mass disasters [25]. Anthropologists observe and compare the relationship between body segments to highlight variation between ethnic groups [26, 27, 10]. The aim of the present study was to investigate gender differences in body mass index (BMI) and Mid-upper arm circumference (UMAC) distribution in Nigerian School Children of Gbagyi ethnic group.

METHODS

The study was carried out from three different Local Authority Primary School namely; Byazhin, Aziyapi, Kubwa II all in Bwari Local Government Area of Abuja-Nigeria, belonging to the Gbagyi ethnic group in June, 2011. The sample consists of 300 males and 300 females with each school having 100 males and 100 females with no known physical deformities between the ages of 5-10 years. The study participants were boys and girls between the ages of 5-10 years of age, of Gbagyi tribe from both parents and grandparents within Abuja Area of Nigeria and without any known Physical or Mental deformity.

The demographic data collected from the subjects include age in years, name, place of birth, parental and grandparental origin was completed in questionnaire. Standing height, weight and Mid-upper arm circumference (MUAC) measurements were taken. Standing height was measured to the nearest centimeters (cm) using a Stadiometer with subject standing erect on a horizontal resting plane bare footed having the palms of the hands facing forward and the finger pointing downwards. The measurements were taken from the sole of the feet to the vertex of the head as recommended by International Biological Program [28, 12].

The body weights of the subjects were taken using the mechanical weighing balance to the nearest kg according to the standard procedures [29, 30]. BMI was then calculated by dividing weight by converted height in meters squared [12, 31]. BMI is a number calculated from a child's weight and height, and is a reliable indicator of body fatness for most children and teens. The mid upper arm circumference (MUAC) was

measured to the nearest cm using a calibrated non stretch tape with the left arm hanging relaxed [32] and was taken midway between the tip of acromion and olecranon process as described by Amirshaybani and others [7]. The measurements and readings from each subject were taken twice and recorded and if the two measurements and readings for each parameter agreed within 0.4 ranges the average was taken as the best estimate for the true value. When the two initial measures did not satisfy the 0.4 range criteria, two additional measurements and readings were made and the mean of the closest records was used as the best estimate [34].

STATISTICAL ANALYSIS

Data was expressed as mean \pm standard deviation (\pm SD). Pearson's correlation analysis was used to determine the strength of the relationship between the parameters studied. Students' T-test was used to test the significant levels between the body proportions studied both in males and females. Differences were declared significant when P – value is less than 0.05 ($P \leq 0.05$) and correlation exist when $P \leq 0.001$. To investigate the utility of hand length, weight, age and BMI in height estimation, linear and multiple linear regression analysis were used.

RESULTS

The results from the present study show the mean \pm SD of height in male Children was 1.20 ± 0.12 m, the mean \pm SD of age, weight, and body mass index are shown in Table 1. The mean height in female Children was 1.21 ± 0.12 m and the mean of age, weight, and body mass index are shown in Table 2. There was significant difference ($P \leq 0.05$) between male and female School children in the age and weight but there was no significant difference ($P \leq 0.05$) in the height between the male and female Nigerian school children of Gbagyi tribe of Abuja.

The results in Table 3 show the mean and standard deviation of height, weight and BMI of each age group in both males and females. The results show that height, weight and BMI was significantly increased with age of the Gbagyi school children of Nigeria in both males and females ($P \leq 0.05$). The results show that there was a proportional relationship between age and the parameters studied and an age dependent increase in height and an age dependent significant increase in weight and BMI in males ($P \leq 0.05$) except for BMI in which there was a decrease in ages 8 and 9 years which was not statistically significant. The females show an age dependent significant increase in height, weight and BMI, except for the age 9 years in which BMI was not significantly decreased ($P \leq 0.05$).

The result in Table 4 shows the correlation matrix of the anthropometric parameters studied. The result shows a 2-tailed correlation ($P \leq 0.001$) between height and age ($r=0.820$; 0.738), weight ($r=0.827$; 0.805) and BMI ($r=0.164$; 0.030) in males and females respectively. There was a 2-tailed correlation ($p \leq 0.001$) between height and age ($r = 0.778$), weight ($r = 0.705$) and BMI ($r = 0.894$) in both male and female Nigerian school children of Gbagyi tribe of Abuja.

The result in Table 5 shows the linear regression of height (m) from age (years), weight (kg) and BMI

(kg/m^2) of the male and female school children of Gbagyi tribe of Abuja. The table shows the standard error of estimate (SEE) not more than 0.099m and 0.091m for the prediction of height in males and females respectively, and for the total not more than 0.095m . The linear regression equation for estimation of height from age (years), weight and BMI shows there was a positive correlation ($p \leq 0.001$) between gender and other parameters studied.

Table 1: Anthropometric Measurements in both male and female School Children

	Male Children	Range	Female Children	Range
Variables	n= 300	Min-Max	n=300	Min-Max
Age (years)	7.10 \pm 1.98	5.0-10.0	7.68 \pm 1.86*	5.0-10.0
Height (m)	1.20 \pm 0.12	1.0 \pm 1.51	1.21 \pm 0.12	0.99-1.50
Weight (kg)	22.53 \pm 6.14	11.0-39.0	23.77 \pm 5.91*	11.0-37.0
MUAC (cm)	17.84 \pm 2.07	13.0-24.0	18.31 \pm 2.35*	13.0-37.0
BMI (kg/m^2)	15.49 \pm 2.45	8.77-26.63	16.11 \pm 2.59	8.61-26.93

* $P \leq 0.05$: Shows there was a significant difference

Table 2: Anthropometric parameters according to the age groups in male children

Male School Children						
Age Group (yrs)	5	6	7	8	9	10
N	96	60	26	22	32	65
Height (m)	1.09 \pm 0.06	1.16 \pm 0.06	1.20 \pm 0.05	1.23 \pm 0.07	1.29 \pm 0.08	1.34 \pm 0.09*
Weight (kg)	17.07 \pm 2.7	19.77 \pm 3.39	24.62 \pm 3.75	24.96 \pm 4.45	26.88 \pm 4.38	29.25 \pm 4.78*
MUAC (cm)	17.06 \pm 1.8	16.87 \pm 1.50	17.58 \pm 1.53	18.27 \pm 2.59	18.22 \pm 1.45	19.63 \pm 1.99*
BMI (kg/m^2)	14.50 \pm 2.0	14.73 \pm 2.28	17.04 \pm 2.48	16.47 \pm 2.40	16.17 \pm 2.64	16.37 \pm 2.38*

* $P \leq 0.05$: Shows there was a significant difference

Table 3: Anthropometric parameters used according to age groups in Female Children

Female School Children						
Age Group (yrs)	5	6	7	8	9	10
N	55	48	30	35	48	74
Height (m)	1.08 \pm 0.05	1.14 \pm 0.07	1.17 \pm 0.07	1.21 \pm 0.08	1.27 \pm 0.07	1.32 \pm 0.11*
Weight (kg)	17.27 \pm 3.4	19.94 \pm 3.98	22.57 \pm 4.57	23.98 \pm 3.71	25.75 \pm 3.21	30.16 \pm 3.99*
MUAC (cm)	16.55 \pm 1.41	17.00 \pm 1.79	17.77 \pm 1.98	18.24 \pm 1.60	18.92 \pm 1.84	20.35 \pm 1.84*
BMI (kg/m^2)	14.75 \pm 2.81	15.25 \pm 1.84	16.37 \pm 2.81	16.58 \pm 2.53	15.99 \pm 1.52	17.37 \pm 2.70*

* $P \leq 0.05$: Shows there was a significant difference

Table 4: Correlation Matrix of the anthropometric parameters used among Nigeria School children of Gbagyi tribe.

Variables	Ages	Weight	Height	MUAC	BMI
Boys (N=300)					
Ages			0.820**		
Weight			0.827**		0.682**
Height	0.820**	0.827**		0.545**	0.164*
MUAC		0.545**			
BMI		0.682**	0.164*		
Girls (N=300)					
Ages			0.738**		
Weight			0.805**		0.607**
Height				0.649**	0.30**
MUAC			0.649**		
BMI		0.607**			

Table 4 shows the level of significant between parameters studied in school children of Gbagyi tribe of Abuja Nigeria.
 $P < 0.001$ **shows there was a high correlation between the parameters.
 *shows there is low correlation between the parameters.

Table 5: Linear regression of height in males and females from the parameters studied among the school children of Gbagyi tribe of Abuja

Variables	Height Predictive Equation	SEE	R	R ²	P
Males (N=300)					
Ht & Age	Ht=0.85+0.04Age	0.068	0.82	0.672	<0.001
Ht & Wt	Ht=0.838+0.02Wt	0.067	0.827	0.683	<0.001
Ht & MUAC	Ht=0.64+0.03MUAC	0.099	0.545	0.297	<0.001
Ht & BMI	Ht=0.1.07+0.01BMI	0.012	0.164	0.027	<0.001
Females(N=300)					
Ht & Age	Ht=0.85+0.05Age	0.080	0.738	0.545	<0.001
Ht & Wt	Ht=0.826+0.02Wt	0.070	0.805	0.648	<0.001
Ht & MUAC	Ht=0.61+0.033MUAC	0.090	0.649	0.421	<0.001
Ht & BMI	Ht=1.19+0.001BMI	0.012	0.30	0.09	<0.001

Table 5: Linear regression of height in males and females from the parameters studied among the school children of Gbagyi tribe of Abuja.

DISCUSSION

The result of the present study showed that height, weight, MUAC, and body mass index can successfully be used for the delineation of gender differences in Nigeria School children. The parameters named above showed significant correlation in both male and female Nigeria school children of Gbagyi tribe of Abuja, hence these can be used by law enforcement agents and forensic scientists to identify fragmentary and dismembered human remains in Gbagyi school children of Abuja Nigeria to distinguish between males and females. Since it was an established fact that long bones are the most appropriate specimen for height evaluation [19, 33], height, weight, MUAC and BMI was chosen for this study. It has been shown from this study that there was a 2-tailed significant correlation between height and age, weight, MUAC, and BMI in male and female of Gbagyi school children of Abuja Nigeria which is gender specific.

The use of anthropometric methods are available in case of athletes in which the bone area values at different sites of the body are strongly related to muscle strength and parameters related to body size such as height, weight, lean body mass, fat mass and body mass index according to Ruff and Jasuga and others [34, 33]. Thus morphometric gender estimation of body mass from skeletal frame size appears to work reasonably well in both normal and highly athletic modern humans [34, 33]. The present study shows that the weight could be correlated with height and weight could be correlated with BMI in both male and female Gbagyi school children of Abuja as shown from the present study. This shows that the higher the height, the lower the BMI then the higher the athletic performance according to Ruff and Munoz and others [34, 27]. Estimation of height using various physical measurements has been attempted by many researchers

but the one variable that proves to be consistently reliable in estimating height is the hand length [35, 25]. The results from the present study show that height can be used to predict age, weight, MUAC and BMI. From the present study the parameters used to determine height can also be used to determine weight because there was a 2-tailed significant correlation between height and age, weight, MUAC and BMI in both male and female Nigerian School children of Gbagyi tribe of Abuja.

This study was to establish a relationship between the anthropometric variables of height, age, weight, MUAC and BMI in both male and female Gbagyi primary school children of Nigeria aged between 5 and 10 years and to study if these variables are sexually dimorphic. Analysis of genetically disparate population reveals a clear pattern of sexual dimorphism, with women consistently having smaller stature than men [36, 37]. Therefore while varying in degree across populations in general women have proportionately shorter heights than men [38, 39, 40, 41, 42, 43]. The results from the present study show that, males have shorter height than females (Females = 1.21m; Males = 1.20m) which disagrees with the established pattern of men having longer heights than women according to Quamra and others, Robbins, Davis, Giles and Vallandigham, Barker and Schever and Ozaslan and others [38, 39, 40, 41, 42, 43]. This could be because the present study was carried out in underage children of ages between 5-10 years Nigerian children of Gbagyi tribe of Abuja. Scientifically it is known that a female child grows faster than a male child which show that a female child have a longer height than the male children of Gbagyi tribe of Abuja. The present study tried to create specific regression equations which could help in prediction of height, weight, MUAC and BMI of Nigerian school children of Gbagyi tribe of Abuja. The equation for estimating height, weight, MUAC and BMI from the anthropometric measurements of Nigerian school children of Gbagyi tribe of Abuja which differs from those presented by Bhartnagar and others [20] who carried out studies among the Punjabi male children which could be due to the differences in the average values of parameters studied. The differences could also be due to the different methods and parameters used in the present study.

MUAC is a measure of both energy deficiency in adult and children, and the measurement of MUAC can be regarded as a screening method for underweight, normally assessed from BMI to identify the preferential loss of peripheral tissue stores of fat and protein [44]. BMI and MUAC are sometimes used in conjunction to classify adult nutritional status [45].

The results from the present study show that one male child out of 300 males had MUAC value of 13cm and one female child out of 300 females had MUAC value of 13cm. A MUAC value above 13.5cm is normal for children from ages 2-5 years of age [12]. The MUAC value of a well nourished child is above 13.5cm, between 12 and 13.5cm indicates malnutrition and below 12 indicates more severe malnutrition [12]. Cole and others had reported age-specific BMI standards for defining obesity and overweighted in children [46]. The present study found twenty – eight male Nigerian school children of Gbagyi tribe of Abuja are overweight and six are obese children, while thirty-eight female Nigerian school children of Gbagyi tribe of Abuja are overweight and six are obese children based on BMI guidelines for defining obesity and overweight in children [12, 46].

In conclusion, the results from the present study indicated that height is a proxy indicator for BMI, weight and MUAC when it is difficult or impossible to measure height directly in both males and female Nigerian school children of Gbagyi tribe of Abuja. Also the present study was able to establish gender differences in BMI and MUAC distribution in Nigerian children of Gbagyi tribe of Abuja.

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CONFLICT OF INTEREST

The Authors have no conflict of interest in this research.

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